

REMARKS

Claims 1-35 are in the application. Claims 1, 2, 10, and 21 are amended. Claims 22-35 are new. Support for claims 2 and 22 is at 0003, 0005 and 0036. Support for claims 21, 28 and 34 is at 0028. Support for claim 31 is at 0028. Claim 35 is similar to claim 1, with the added description of applying no other liquid to the workpiece as it is raised out of the aqueous liquid.

The claims describe novel methods for cleaning and drying a workpiece. The methods, in a basic form, need only relatively inexpensive and environmentally friendly substances, e.g., water and an organic solvent, such as isopropyl alcohol (IPA). The claimed methods can advantageously also be carried out within a single processing vessel. This requires less clean room space in the fab or factory, and also reduces the potential for defects in the end products (e.g., semiconductor devices), as the workpieces can be cleaned and dried with less handling and movement.

Election Requirement:

Applicant affirms the election of Group I, claims 1-12 and 21, without traverse. New claims 22-35 are also in Group I.

Response

Turning to the rejections at paragraphs 8 and 11 of the Office Action, Ferrell et al., USP 5,974,689 describes a chemical drying and cleaning system which uses a first liquid, which is DI water or IPA, followed by a second liquid, specifically hydrofluoroether (HFE). Column 2, lines 61-67 and Column 3, lines 20-30. As is clear from Col. 3-5, in Ferrell et al. the objective is to use HFE or a solution containing HFE to displace the first liquid. Ferrell et al. uses HFE because it can displace IPA, water, and

most other liquid substances. Column 3, lines 41-46. HFE displaces the first liquid (water or IPA) because it has a higher density than the first liquid. HFE also has a lower surface tension.

In contrast to the displacement mechanism of Ferrell et al, Claims 1 and 21 describe a Marangoni method wherein the IPA vapor creates a surface tension gradient which pulls liquid from the wafer surface. See the Application at paragraphs 0007 and 0028. This is a surface tension effect, rather than a displacement effect as disclosed in Ferrell et al. Indeed, a vapor, as in claims 1 and 21, cannot displace a liquid. Moreover, the claimed organic vapor, even if in a liquid form, has a density less than water. Hence, the aqueous solution of claims 1 and 21 cannot be equated to the first liquid in Ferrell et al, because it has a density greater than the drying fluid, i.e., the organic vapor.

In Ferrell et al, after the second liquid or HFE has displaced the first liquid, the workpiece is wet with the HFE. The actual drying in Ferrell et al relies on evaporation of the HFE from the workpiece surface. In contrast, in the claimed methods, the workpiece is dry as it emerges from the liquid interface due to surface tension effects. There is no evaporation needed or used. As is apparent, the surface tension drying mechanism of the claims is entirely different from displacement/evaporation mechanism in Ferrell et al.

A careful reading of Ferrell et al. makes clear that only a two liquid system is described. Column 2, lines 8-10 and 18-20; column 2, lines 60-62; column 3, lines 20-28; and column 7, lines 6-12 and 22-26. There is no suggestion anywhere in Ferrell et al. of use of an aqueous solution and an organic vapor as described in claims 1 and 21.

Rather, Ferrell et al. expressly describes use of either an aqueous solution (e.g., DI water) or IPA, as the first liquid. There is no suggestion in Ferrell et al. of using both DI water and IPA together. Rather, they are described exclusively as alternative liquids for use as the "first processing liquid." Column 2, lines 60-67. Similarly, there is no suggestion at all in Ferrell et al for immersing a workpiece in a first aqueous liquid or DI water followed by application of an organic vapor (in a Marangoni drying process) in the presence of sonic agitation.

In Ferrell et al., IPA may be used as the first liquid. Accordingly, Ferrell et al. teaches away from use of IPA, or similar solvents, as a second liquid, because the second liquid in Ferrell et al. displaces the first liquid via differences in surface tension and density. Column 3, lines 41-64. Accordingly, there is no suggestion in Ferrell et al. for using solvents such as IPA to reduce surface tension of an aqueous liquid, as claimed.

Claims 1 and 21 describe an organic vapor. At Col. 3, line 48, Ferrell et al mentions use of a "fog" of HFE. However, the objective of the "fog" is to create a liquid film on the wafer as it is withdrawn from the first liquid. The "fog" is therefore an aspect of the Ferrell et al liquid displacement mechanism. In contrast, the claimed organic vapor is what causes the claimed surface tension mechanism directly resulting in the drying.

Claims 1 and 21 use inexpensive and relatively environmentally friendly substances, i.e., an aqueous solution and an organic solvent, such as IPA. Only a single solution (i.e., an aqueous solution) is needed. In contrast, Ferrell et al. uses

HFE, an expensive chemical with additional handling requirements. Ferrell et al. also requires first and second liquids, i.e., DI water or IPA (but not both) as the first liquid (column 2, lines 60-66), with HFE as the second liquid.

As described on the attached information sheet from 3M, HFE-7100, i.e., the second liquid in Ferrell et al., is not a volatile organic compound. In contrast, claims 13 (non-elected) and 21, as well as several new claims, describe use of a volatile or substantially volatile organic substance, or use of IPA.

Taken as a whole, Ferrell et al is ambiguous as to the steps performed. Ferrell et al., at Col. 3 (lines 1-5) first states that the workpiece is immersed in the first liquid, but then immediately also states that "Alternatively, the workpiece(s) need not be immersed in the first processing liquid." (emphasis added). Ferrell et al. provides a similarly ambiguous description of use of ultrasonics. At Column 3, line 4, Ferrell et al states that "The first liquid is optionally exposed to ultrasonic vibrations..." (emphasis added). In contrast, in the claims, the workpiece must be immersed and must be exposed to sonic vibration.

In view of the foregoing, it is submitted that the claims are allowable. A Notice of Allowance is requested.

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